Transport Research Laboratory

Climate Change Resilience Indicators

by P M Sivell, S J Reeves, L Baldachin and T G Brightman

for South East England Regional Assembly

CPR117

CLIENT PROJECT REPORT

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Prepared for: **South East England Regional Assembly**

Client: **Kate Aulman, SEERA**

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	Name	Date Approved
Project Manager	Phil Sivell	09/09/08
Technical Referee	Jacquie Berry	09/09/08

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Executive summary

Climate change is already affecting the South East of England and the UK Climate Impacts Programme climate change scenarios released in 2002 (UKCIP02)[1] predict that these impacts will become more severe. There is a rising appreciation of the need to adapt to the changing climate in order for the region to prosper in the future. Adaptation actions can be thought of in terms of:

- Increasing resistance to climate change- i.e. preventing impacts
- Increasing resilience- i.e. the ability to recover from impacts
- Increasing the readiness- i.e. the ability to take advantage of opportunities.

As part of its response to the need to adapt to inevitable climate change, the South East England Regional Assembly (SEERA) would like to be able to measure the development of the region's resilience to climate change. This will support the Regional Sustainability Framework (RSF) and aid in monitoring the South East Plan. Accordingly, SEERA commissioned TRL to provide technical support in its development of a set of resilience indicators for the region. The objectives of the project were to review indicators already being used in this area and propose new indicators as appropriate.

The paucity of currently used climate change resilience and adaptation indicators demonstrated the complexity of measuring such an all encompassing concept. Climate change resilience in itself is difficult to define and is a product of a potentially vast range of aspects covering all sectors of society. A definition of terms is included to ensure a common language within which the concept of regional resilience to climate change can be further explored.

The conclusions of the review are that there were no pre-existing specific measures of regional resilience to climate change. Furthermore the review concluded that no single indicator, or even a set of 3 or 4 individual indicators, could adequately measure a region's resilience.

Another key conclusion is that there is no absolute measure of resilience. Resilience is relative – relative to the condition that you are preparing for, and relative to the location of the space that is being considered.

Therefore we propose the generation of a set of compound indicators to be presented as a radar diagram. The three indicators we feel are most suitable measure the resilience of the three aspects of sustainability; social, economic and natural/environmental. Each of these aspects will be scored from 1 to 5 using a compound indicator which combines other indicators, many of which are already collected to monitor the sustainability of the region. In this scoping report we set out this proposed method of measuring resilience, describe the possible indicators that could be included and the assessment and scoring process. The report also suggests that in the future more targeted indicators could be developed.

[1] Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Hulme, M, et al; Tyndall Centre for Climate Change Research

This approach appears to have merit and warrants further development and discussion with key regional stakeholders. It could prove to be a useful tool in helping the region adapt to future climate change.

1 Introduction

The impacts of climate change are becoming increasingly evident. The climate change scenarios produced by UKCIP predict that these effects will become increasingly severe and that the south east will be the region of the UK where these changes will be most marked. As the consequences of climate change, such as flooding of people's homes and important infrastructure, water shortages, transport disruption and health impacts, especially for the elderly, become clearer the need to adapt to these changes is becoming more urgent.

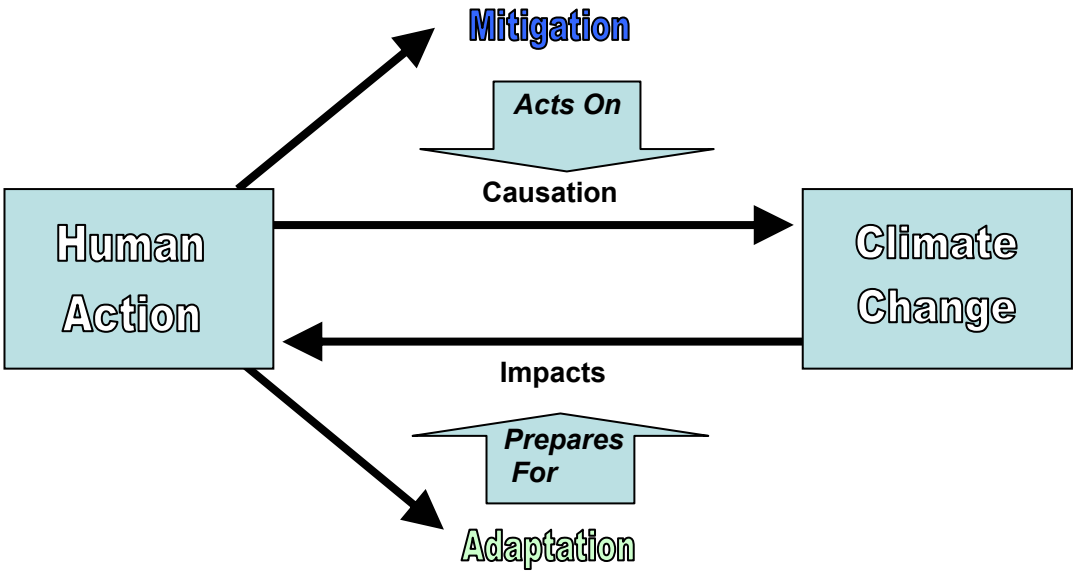
Planning and Climate Change: Supplement to Planning Policy Statement 1[2] refers to the need for new developments being planned to minimise vulnerability and for the need for clear yardsticks and appropriate indicators against which future trends can be measured. It also provides some general principles against which approaches to monitoring should be assessed. It does not however make any reference to resilience or give examples of yardsticks and indicators for climate adaptation and resilience. However, it does outline some general principles that are useful in developing the approach to monitoring in this new area. The discussion in this report on the nature and design of resilience indicators follows these general principles.

The South East England Regional Assembly (SEERA) recognises the need to increase the resilience of the region to the impacts of climate change. It also recognises that in order to carry this out effectively it is useful to be able to measure progress over time and identify the areas that are most in need of attention. SEERA have commissioned TRL to help them develop an appropriate set of indicators to measure climate change resilience in the region. This project involves a review of indicators that could be used to monitor climate change adaptation and the development of a set of indicators appropriate for monitoring climate change resilience in the south east. Before this can take place it is useful to define the types of responses that can be taken when responding to climate change.

2 Responses to climate change

The response to the challenges and opportunities of climate change has resulted in its own language developing, where different aspects of the responses are clearly delineated by those involved. In order to have a clear debate regarding the development and use of resilience indicators, it is useful to first clarify the terms used. A diagrammatic representation of the relationship between human activity and the elements of climate change is shown as Figure 2.1.

[2] *Planning and Climate Change: Supplement to Planning Policy Statement ; Department for Communities and Local Government. HMSO; 2007*



After UK Climate Impacts Programme

Figure 2.1 - The relationship between human actions and climate change

2.1 Mitigation

Measures to reduce the emissions of the gases that result in the enhanced greenhouse effect and anthropogenic (human induced) climate change. These include actions such as increasing energy efficiency, the use of renewable energy, reducing the embodied carbon in material and/or construction, changes in land use, etc. It is the subject of the Kyoto Protocol and the various emission trading schemes. It is the counterpoint to *adaptation* – actions taken to address the impacts of inevitable climate change.

2.2 Adaptation

Adaptation is a blanket term which covers all actions taken to address the changes that climate change is bringing. Building *Resistance* and *Resilience* both contribute to adaptation, as does the *Readiness* to act on the potential opportunities. It is the counterpoint to *mitigation* – actions taken to prevent further climate change. A diagrammatic representation of the various elements of adaptation that are discussed below is shown in Figure 2.2.

2.2.1 Adaptation actions

Adaptation Actions are those actions which cause adaptation. Building flood defences is an adaptation action, as are putting more nails in a roof tile, fitting awnings or shutters, or increasing the diameter of a drain. However, it is not the case that all adaptation actions are purposeful. Other actions which were not deliberately aimed at improving adaptation may have secondary impacts which cause adaptation. e.g. designing a building with extensive shading and free cooling to reduce energy use, also helps the building adapt to future weather conditions even though that was not the primary aim. Similarly, not all

adaptation actions require things to be built. Both managed realignment and creating 'siesta' times in a business or locality are adaptation actions.

Adaptation actions are often thought of as costly – building new flood barriers, or carrying out information campaigns to prepare people for the impacts of climate change. It is important to note that they can also be profitable. The most commonly quoted example of this is the potential for new wineries to succeed in the SE as the climate changes, but there are other potential benefits. Exploiting these opportunities, preventing climate change impacting on people, and preparing people to be better able to cope with the impacts of climate change all form part of adaptation.

It is also important to note that sometimes undertaking no adaptation actions will be cost effective and worthwhile. In this case the "do nothing" principle may well prevail: carrying out costly actions which do not bring adequate benefit is a waste of resources.

2.2.2 Adaptive capacity

Adaptive capacity is the ability of a region/agent to react to changes and cope with new conditions. For instance, a relatively rich region with strong networks and communities is likely to have significant adaptive capacity – whatever change comes it is likely to be able to react to the impacts with appropriate adaptation measures. Examples of building adaptive capacity include undertaking research, institutional change, education and training, creating standards and legislation, management, developing policies, plans and strategies. Developing partnership working on climate change is also an example of building adaptive capacity.

There is some "grey area" between adaptive capacity and *adaptation actions*. Strictly speaking, adaptive capacity is the potential for future adaptation in reaction to events, but it may be argued that because adaptive capacity prepares a region for future impacts, it contributes to the overall adaptation of that region.

2.2.3 Resistance

Resistance is a type of *adaptation action* that protects an area from the impacts of climate change. The archetypal example of resistance is the flood barrier – as long as the barrier remains unbreached, the area behind it is protected from flooding events. Resistance is easy to understand – it is putting some barrier in the way of the effects of climate change, so that the thing you are protecting remains unaffected by those effects. It is commonly the first response to climate change adaptation.

However, resistance is by its nature almost entirely "all or nothing". A five foot flood barrier when you have six feet of flooding is very little use. While resistance can protect you completely from some events, it becomes impractical or prohibitively expensive to ensure that resistance measures will work in all cases. As such, an important part of adapting to climate change is *resilience*.

2.2.4 Resilience

Where *resistance* involves completely blocking the effects of a particular event, resilience is about how damaging an event will be, and how quickly and easily it is to recover from such an event. For example, while two communities might be initially hard hit by a flood, the resilient one could be back up and running within a week. Whereas the non-resilient one might have most residents displaced from homes for long periods of time. Similarly local businesses may be forced to close down because of the long term impacts of the event. The event might cost millions of pounds in the non-resilient community, and only tens of thousands in the resilient one.

Resilience is comprised of many factors, depending on the specific event, and what is being protected. It runs the gamut from well established coping strategies (*adaptive capacity*) for emergency services, adequate insurance, plans to move vulnerable residents to air conditioned spaces during heat waves, houses designed so that flooding does minimal damage (*adaptation action*) and information provision to prepare communities.

Notably, resilience is not necessarily about physical measures. Resilience can be gained through changes in management, procedure and awareness. It also does not necessarily involve spending large amounts of money – changes in how existing funds are distributed can be very effective in building resilience.

One way to make an area resilient is to protect individual assets within it – that is to make an area resilient to flooding, make each dwelling resistant, so even if the area is flooded the amount of damage is limited.

If you think of adaptation efforts as being something like a boxer, resistance is blocking the punches. When punches inevitably get through, resilience is about not having a "glass jaw" and being able to avoid the worst effects of any given event.

2.2.5 Vulnerability

As in any other field, vulnerability is a term referring to the total exposure to risk, in this case those risks associated with climate change. These risks tend to grow as the extent of the expected changes increases. This is a result of both the number of impact events and the severity (consequences) of those events increasing. Vulnerability is reduced through improving both *resistance* and *resilience* – *Resistance* reduces the number of impacts that are likely to significantly affect you, while *resilience* reduces the extent of the damage caused by impacts that do affect you.

2.2.6 Readiness

There are three main factors which make up adaptation. These are *resilience*, *resistance*, and a third we have dubbed readiness, which refers to the ability of a society or organisation to take advantage of the opportunities which climate change will present. Where *Resistance* and *Resilience* are about preparing for and adapting to the negative impacts of climate change, *readiness* is about preparing for and adapting to the positive effects.

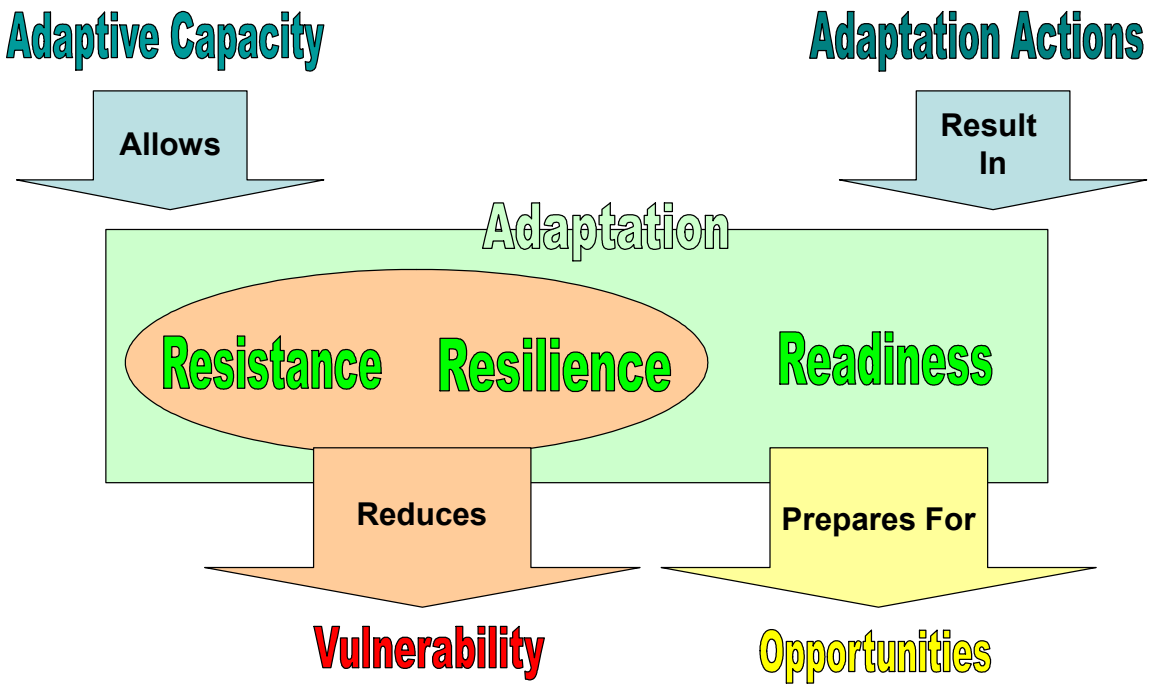


Figure 2.2 - The elements of climate adaptation

3 Climate change and the south east

All these types of responses are necessary in order for the south east region to prosper in the future. We need to both reduce the greenhouse gas emissions emitted to prevent future catastrophic global climate change and we need to adapt to the changing climate now and prepare for the future. The changes in climate facing the UK have been set out in the UKCIP scenarios based on the Met Office Hadley Centre global climate model predictions. The current scenarios, UKCIP02, predict the UK will experience hotter drier summers, wetter milder winters, rising sea levels and more intense rainfall events. The trends report for the forthcoming UKCIP08 scenarios, *The climate of the United Kingdom and recent trends*[3], supports these predictions and confirms that the south east is already experiencing summer temperatures on average 1.02°C hotter than in the past and a decrease in summer precipitation by 15.3%. The climate in the south east is expected to continue to change, so that in the 2080s it will experience:

- Up to 5°C temperature rise during summer months
- Up to 50% decrease in summer rainfall
- Sea levels could be between 26 and 86 cm above the current level
- An increase in winter precipitation of up to 30%
- Up to 94% decrease in snow and 50% decrease in frost

[3] The climate of the United Kingdom and recent trends; Jenkins, G.J, et al, UK Met Office 2007

Even more important than these changes in average conditions, is the increase in frequency and intensity of extremes as it is normally the extremes that cause the most damage. It is expected that the UK of the 2080s will experience:

- x10 to x20 increase in extremely warm summer days
- 24-hour-average summer temperature of 30ºC or more might be expected on average once every ten days
- x10 to x20 increase in warm summer nights
- "Record" (1 in 10 years) hot temperatures predicted to be 7ºC hotter
- Three times the number of winter heavy rainfall days and 3-4mm more rainfall per event
- Possible increase in storminess
- In some locations high sea levels that currently have a 2% chance of occurring in any given year could occur between 10 and 20 times more frequently

These changes in climate have significant consequences for people living in the south east. For example:

- The change in rainfall patterns will create problems with flooding damaging people's homes, vulnerable infrastructure, businesses and transport links. The decrease in summer rainfall will cause drought with the potential for water shortages for homes and industry, increased incidences of subsidence and damage to agriculture and the natural environment.
- Higher temperatures have health implications, especially for the elderly and can damage transport infrastructure. High temperatures also decrease productivity. According to the Centre for Economics and Business Research (CEBR, 2003) productivity at 26^{o}C falls by 8% (costing the UK £35M per day), at 32^{o}C it falls by 29% (costing £126M per day) and at 38^{o}C it falls by 62% (£270M per day).

These impacts threaten the social, economic and natural aspects of our society. It is these changes in the frequency and intensity of extreme events that will most test the region's resilience, and that will be the conditions that need to be designed for. However actions can be taken to reduce these negative impacts and take advantage of any opportunities, provided that society is prepared and forward looking.

4 Resilience indicators

A review of indicators already being used has demonstrated the difficulty of developing indicators for an issue as wide ranging as resilience to climate change. A small number of adaptation indicators are currently in use at a range of scales, either national, regional, local and/or for different sectors. The most significant of these is the new performance indicator for local authorities to measure adaptation under the new Comprehensive Area Assessment regime (NI

188). Here the difficulty of measuring adaptation has been addressed by introducing a process orientated indicator. Local authorities are monitored on the progress they have made in identifying adaptation actions in different sectors and how far they have been implemented. This indicator (NI 188) has been adopted by a significant number of local authorities in their Local Area Agreements. However, this is not a resilience indicator.

Many indicators are utilised by numerous organisations in the South East Region to measure progress towards the objectives of their policies and programmes. Whilst the Regional Sustainability Framework is the current overarching sustainable development document, the concept of a Region's resilience to climate change impacts pushes beyond what is expected of Regional Assembly and the RSF. Therefore, it is very likely that other indicators (monitored by other organisations) would be useful for contributing to an indicator for Resilience in the South East. These indicators can be found in strategic documents such as the Regional Economic Strategy or State of the Environment Report and observation databases such as the National Health Service health inequalities database compiled by the London Health Observatory.

Other indicators relating to specific sectors could include:

- Identification of clay or other shrinkage prone soils
- Physically active adults
- Excess winter death index
- Supply-demand balance (water)
- Leakage

Further examples of indicators used in English regions in respect of climate change that were found during the review can be found in Annex 1.

The conclusions of the review were that an appropriate resilience indicator for the region was not currently in use or published in the literature. As a result a new type of indicator would need to be developed in order to meet the Regional Assembly's desire to measure the development of the region's resilience to climate change.

Climate change will impact on all aspects of society, although not in equal measure. This requires more than a simple indicator measuring one dimension or attribute. It is also important to recognise that that this is not an absolute measure, but is a relative measure showing that a society has become more or less resilient compared to an earlier reference period. As a result it is an indicator in the true sense of the word.

4.1 Compound indicators

To address the issue of monitoring regional resilience requires the use of a compound indicator measuring a number of different attributes within a single measure. One method of doing this, often used to assess the vulnerability or adaptation capacity of developing countries, is to produce a radar graph illustrating the different aspects of a community.

The main aspects that make up a society can be thought of as:

- Social
- Natural (or environmental)
- Economic

Each of these aspects will be impacted by climate change and will demonstrate a greater or lesser resilience. Behind each of these aspects are the characteristics that make up a community that is resilient to climate change. For example, behind the social aspect are characteristics such as what proportion of the community has a low income, what proportion of the community lives in isolated rural areas, ease of access to essential services, etc. A community that scores highly in these areas is more likely to be more resilient to the changes in extreme weather events that are associated with climate change.

Each aspect can be examined in this way and the characteristics which a resilient community would have in each of these areas can be evaluated. These individual characteristics may already be measured and reported as indicators. The characteristics of a community resilient to climate change are often those aspirations that the Regional Assembly are already working towards, for example, improving access to health care. However, considering these characteristics in the light of climate resilience and setting them out in this manner will highlight the areas progressing well and those where more help is required. Therefore our proposal is to use existing indicators grouped together under these three aspects to construct a means to monitor how regional climate change resilience develops over time.

4.2 Presentational approaches

The indicators representing the chosen community characteristics are then combined (possibly weighted) to provide an overall score for each aspect. An example of the approach using illustrative numbers is given below in Figure 4.1.

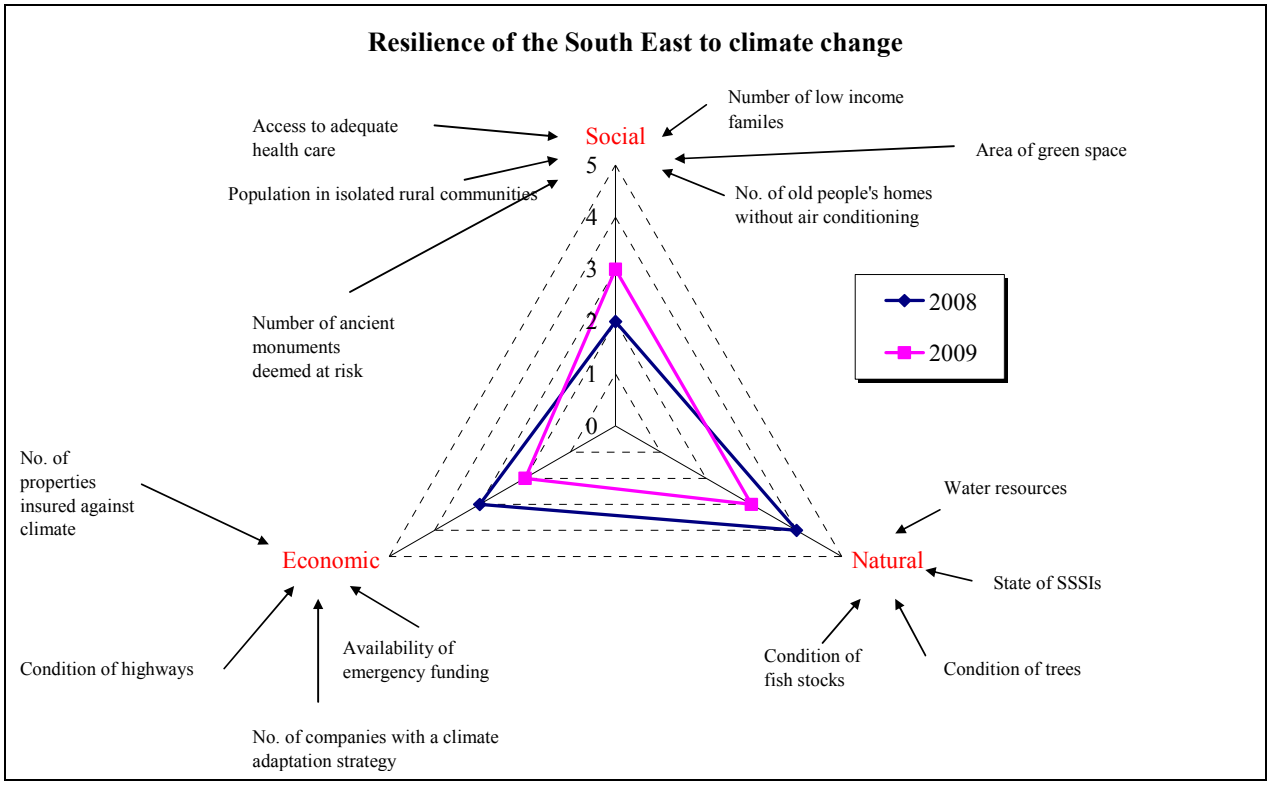


Figure 4.1- Radar plot illustrating resilience of the South East to climate change

The number of aspects could be expanded to more specific sectors, for example:

- Transport
- Health
- Environment
- Housing
- Infrastructure

The number and type of aspects can be chosen to reflect the priorities of the Regional Assembly or the degree of simplicity/information required. Other examples of using this method, with differing numbers of aspects are given below in Figure 4.2 and Figure 4.3. These are taken from the international development field where this approach has been widely used.

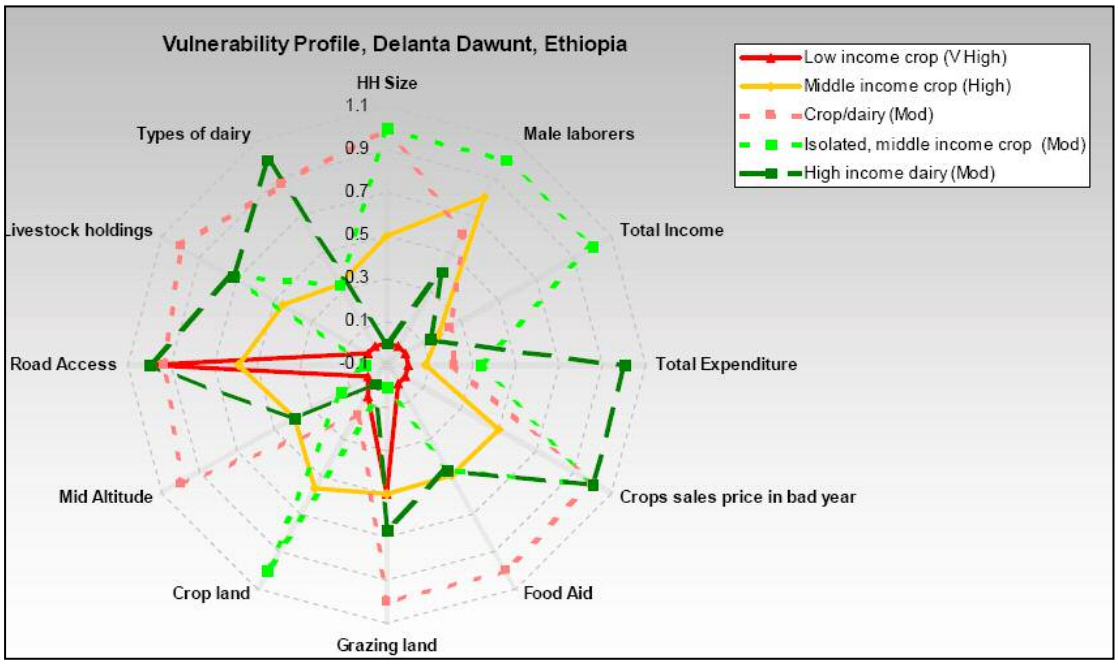


Figure 4.2 - "Radar" plot, illustrating 12 aspects

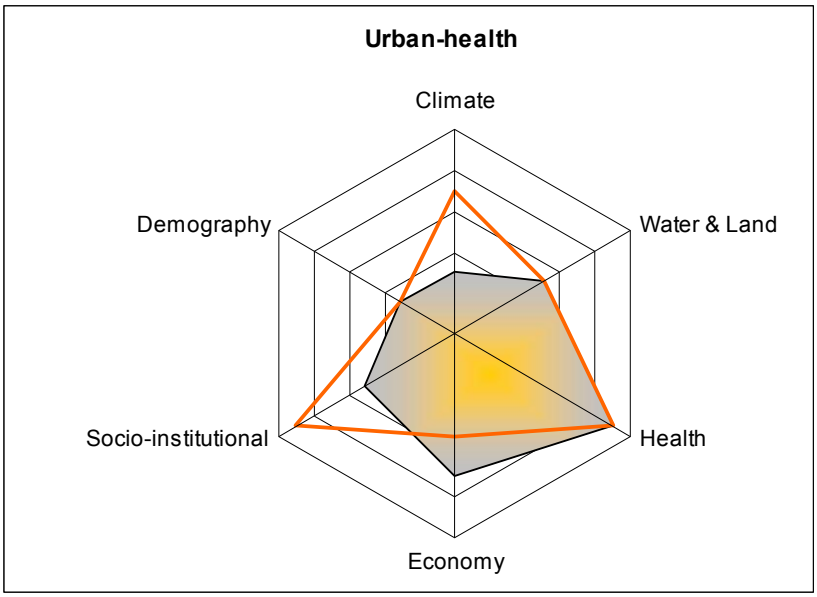


Figure 4.3 - "Radar" plot, illustrating 6 aspects

4.2.1 Interpretation

On balance it is felt that three aspects are the most appropriate for the south east region. They reflect the principle elements of sustainability, while remaining relatively straight-forward.

One element to consider is what does this approach say about an area's resilience? Clearly it is not as straight-forward as a single numeric indicator. There are two components to consider.

Firstly, it indicates the balance of resilience across the aspects, and hence the aspects which are more or less resilient than others, and how those change over time. In the example in Figure 4.1, the natural and social aspects are more resilient than the economic aspect, and the economic aspect is less resilient in 2009 than in 2008.

This indication is useful because it can reveal weaknesses in resilience where a single numeric indicator would obscure those weaknesses. With a single numeric indicator, it would be possible for two areas to have high resilience and the third be very vulnerable and the indicator would report reasonably good resilience. A three pronged approach as in Figure 4.1 avoids this potential pitfall, and makes visible the areas where more action is needed.

Secondly, the area contained within the plot reflects the overall resilience of the region being considered. It scales with each of the three axes, and also reflects that when (for instance) two of the measures reflect a high resilience, and the third reflects a lower resilience, improvements to this weaker area have the greatest impact on overall resilience.

As a region builds resilience the number of events which will cause any given level of damage is reduced. If one sector remains exposed to a lower level of impact causing a significant level of damage, the region still faces potentially significant damage from that lower level of impact. By improving the resilience of the least resilient sector, the region will see more effect than by a similar amount of improvement in an already resilient sector.

However, it is not an absolute measure, as it depends on the individual indicators chosen to illustrate each aspect.

5 Key points to consider when setting resilience indicators

5.1 Individual and collective resilience

Individual resilience is influenced by a wide range of factors, including :-

- poverty;
- dependence;
- disposable income;
- location;
- adaptability;
- state of housing (including tenure);
- awareness.

That is, a range of disparate factors, often related to wealth and the extent of social support networks, covering the all of social, economic and natural aspects. It tends to be the poor, the disadvantaged and the unaware who are least resilient. The sum of individual resilience is an important element when considering the social aspect of the collective resilience of an area.

Collective resilience is similarly influenced by another range of factors, including:-

- resources (GDP):
- institutional networks and structures;
- inequality;
- geography;
- economic structure;
- landscape;
- ecology;
- governance (in particular coordination between various actors).

As with individual resilience, wealthier regions tend to have a capacity for greater resilience. However, that does not mean that they are already more resilient, merely that they have the capacity to become so. In fact a region with great wealth, and therefore an extensive stock of assets, but with low levels of resilience may be at greater risk than a poorer but more resilient region.

As well as considering resilience from an individual or collective basis, it is possible and even desirable, to consider resilience from the various aspects.

The following sections describe a number of indicators that have been collected in the region that could be used to measure resilience. Some of these are no longer collected but have been included below to illustrate the range of elements that could be used to assess resilience. However, for the draft resilience indicator presented in this report, only indicators from the current Regional Sustainability Framework have been used. Other indicators could be incorporated at a later date (See sections 5.2.2., 5.3.2 and 5.4.2).

It is important to note that it is not possible at this point in time to assess all elements that would contribute to a region's resilience. For example, overheating is a key issue and the cause of a large number of excess deaths in Europe during the heatwave in the summer of 2003. While it is possible to collect data concerning the number of excess deaths during a heatwave period, it is extremely difficult to determine the indicator that would describe the vulnerability of a region's stock of buildings to overheating. It is considered that while this might theoretically be possible, it would be extremely time consuming to develop and would distract resources from the overall assessment of regional resilience.

5.2 Social resilience - Key themes and possible proxy indicators

Regional social resilience is about the inter-relationship between the resilience of individual members of a society and adequacy of the social and governmental networks that support them.

The most resilient societies are those where both the individual and the underpinning networks are resilient. For example, a dwelling in a community may be resilient to flooding, i.e. the dwellings are designed to deal with being flooded and the residents may have an appropriate store of food, but if their water supply is disrupted (as happened in Gloucester in 2007) they are reliant on society to restore their water supply.

Key themes or factors could include:-

- Individual incomes;
- access to key services (particularly in rural areas);
- health;
- quality of life;
- culture;
- sense of community

For example, household income, particularly disposable income, is a reflection of the accessibility of resources, i.e. can an individual afford to pay to keep themselves, or vulnerable family members, cool in the event of a severe heat wave?

Access to services – for instance in a severe storm, a household may initially cope well with the immediate conditions, but find any problems they have exacerbated by long periods without power supply if cables are brought down, or by lack of access to healthcare if transport routes are blocked following the event. Ensuring access to services may be relatively straightforward in an urban setting, but may be difficult if they are in an isolated rural community.

Heatwaves are expected to become both more common and more intense. As a result, we might expect more incidences like the summer of 2003 when in excess of 35,000 people died across Europe as a direct result of the heatwave. These were overwhelmingly the frail and elderly. Does society know where these vulnerable people live; does it have a plan to help them in the event of a heatwave?

5.2.1 Possible existing social indicators

A broad range of indicators are, or have been, recorded within the region to support the assessment of various policies and strategies. In many respects what reason the indicators are collected for is less important than that they reflect an aspect of resilience.

The Regional Sustainability Framework contains objectives and indicators, some of which are well suited to providing these monitoring elements. These include:-

- 1f (Percentage of new build and retrofit homes meeting Ecohomes Very Good standard or above or equivalent Code for Sustainable Homes);
- 2a (Early death rates from circulatory disease, cancer, accidents and suicide);

- 2d (Life expectancy)
- 2g (The extent to which older people receive the support they need to live independently at home);
- 3b (Percentage of population of working age who are claiming key benefits);
- 3c (Percentage of households in fuel poverty);
- 3d (Proportion of population who live in areas that rank within the most deprived 20% of areas in the country);
- 6b (Percentage of people who say they are happy with their local area as a place to live);
- 7b (Percentage of rural households at set distance from key services)
- 7c (Access to natural greenspace)

Other measures have been collected at different points in time which could be used for the basis of a compound indicator; i.e. they could provide the individual elements for the social aspect. Examples of these include:

- Percentage of people who have carried out any of a specified list of actions, unpaid, for someone who is not a relative in the past 12 months;
- Percentage of people who have received any of a specific list of actions, unpaid, by someone who is not a relative in the past 12 months.

5.2.2 Possible new social indicator

It is also possible to consider a new indicator (provided that data exists and is easily collectable), e.g. *Persons/households displaced long-term (>3 months) as a result of flooding.*

This is a first order indicator measuring one element of the social impact of flooding. However, it is known that long term displacement from the family home increases stress levels with negative health impacts. It is also likely to have negative impacts on level of attainment at school, as the ability to work "at home", free from disruption is greatly reduced.

Reducing the exposure by reducing the risk of flooding through improved defences (either large of small scale), or moving the dwellings out of (not allowing development in) the flood plain reduces the risk.

Benefits

- It is a measure of the social impacts of the change in frequency/intensity of flooding events, which may be as a result of climate change.
- It is a proxy for the health & educational attainment impacts of flooding.
- It could be applied to the whole of the region, or any administrative sub-set.
- It could be limited to new/recent development.

- It could support regional, sub-regional or local economic development decision making.
- It could help to promote the use of locations which are not at risk/at lower risk of flooding.

Drawbacks

- It is difficult to ascertain the actual health effects and the educational effects.
- It does not deal with dwellings vulnerable to over-heating.
- It could "blight" those locations currently at risk
- The regional bodies can influence only at the margin.

5.3 Economic resilience - Key themes and possible proxy indicators

As with social resilience, economic resilience also potentially covers a wide range of issues. These would include the resilience of local infrastructure – transport, utilities, flood defences; business resilience; availability of contingency funds.

Business resilience alone is a complex matter, affected by a range of issues. These include :-

- Proportion of businesses insured against extreme weather;
- Number of businesses with climate adaptation strategies;
- Nature of business (e.g. service sector, manufacturing, agriculture, process, asset value – buildings, equipment, stock, etc);
- Business practices (distributed v centralised, extent of home working – can staff work at home, do they have broadband?)

Work by the Centre for Economics and Business Research (CEBR) suggests the scale of productivity reduction that businesses are likely to experience as temperatures rise. Compared to an average day, if office temperatures reach 26^{o} C they assert an 8% loss in productivity, at 32^{o} C this becomes a 29% loss, and at 39^{o} C a 62% loss in productivity is likely. This productivity loss is likely to constitute a significant economic drag on the region as summers become hotter. Considering the possible responses which can minimise these losses will make the economy of the South East significantly more resilient to the changing climate.

Evidence from the floods in Carlisle in 2005 suggested that up to 70% of small businesses affected failed to recover, even those with sufficient flood insurance. This is thought to be because by the time they had recovered from the physical effects, their customers had found alternative suppliers. This suggests that businesses, particularly SMEs, need to be able to get back into business very rapidly following a disruption if they are to be able to continue trading. This is very significant for the south east region, where so many businesses are in the SME category.

However, businesses do not act in isolation. They need the supporting infrastructure of the region, whether that is transport, energy, telecommunications or staff. In the event of a flood, a business may not be directly affected, i.e. their premises may be away from the flooded area, but if their staff (or some of them) cannot get into work because their route is flooded, then the business is not resilient.

5.3.1 Possible existing economic indicators

The Regional Sustainability Framework contains a number of objectives and indicators, which are suited to measuring the economic aspect of climate change resilience. These include Objectives:-

- 10 (To sustain economic growth and competitiveness across the region by focussing on the principles of smart growth: raising level of enterprise, productivity and economic activity), and
- 12 (To develop a dynamic, diverse and knowledge based economy that excels in innovation with higher value, lower impact activities), and

Indicators

- 10a (Real GVA per capita growth);
- 11a (Number of income support claimants in the 20% most deprived areas);
- 12a (The percentage of total South east business turnover attributable to new (new to market) and significantly improved products);
- 12c (The expenditure on R & D as a proportion of GVA);
- 13b (Working age population qualified to at least level 4 or higher).

Other economic objectives have been developed that could be used as a proxy for the inclusion of each indicator they are composed of. We believe the approach of using objectives, where there are limited numbers of relevant indicators has merit, allowing a more nuanced compound indicator to be built without inflating the number of contributing factors. However, it does introduce a further subjective judgement and this needs to be balanced against the benefits.

The following Objectives could be used provided that the information supporting them was collected:

- To ensure high and stable levels of employment; and
- To encourage the development of a buoyant sustainable tourism sector.

The inclusion of a tourism measure would have merit as the tourism sector is one of the economic sectors that is frequently referred to as one which may benefit from the predicted climate change.

The economic objectives and indicators that are currently collected are less suitable for use as a measure of resilience than those for the social and natural elements.

5.3.2 Possible new economic indicator

It is also possible to consider a new indicator (provided that data exists and is easily collectable), e.g. *Stock of Wealth at risk*

This is a measure of the value of commercial/business property located in a Floodplain. It would use the business rate mapped against the Environment Agency floodplain maps. However, this gives only a partial view of the value of business assets at risk. For example, it does not consider the value of equipment or stock contained within a premises, neither does it address the issue of localised flooding. However, it does give a picture of the situation and enable change to be observed over time. It is a first order measure of the magnitude of asset potentially at risk. Reducing the exposure by reducing the risk of flooding through improved defences (either large of small scale), or moving the asset out of the floodplain reduces the risk.

Benefits

- It is a measure of the stock of wealth of the region, rather than the flow of money in the region. As such it better relates to the fixed assets of the region.
- As the *Stock of Wealth at risk* decreases the economic resilience of the region as a whole increases.
- It could be applied to the whole of the region's business community, or just that element in which the public realm has an interest. i.e. public assets, developments with public funding, etc.
- It could support regional, sub-regional or local economic development decision making.
- It could help to promote the use of "lower value" locations which are not at risk.

Drawbacks

- It does not say anything about the fixed assets within the building.
- It does not say anything about the resilience of individual buildings.
- It cannot deal with localised flooding.
- It does not deal with buildings/assets vulnerable to over-heating.
- It could "blight" at risk locations.
- The regional bodies can influence only at the margin.

5.4 Natural/Environmental resilience- Key themes and possible proxy indicators

Alongside personal impacts the impacts on landscapes and habitats are arguably the easiest to understand. While many of the impacts are relatively straightforward, measures of the resilience are much less so. For example, an assessment of the vulnerability of a designated site can be undertaken; identifying measures to make that site resilient to climate change is extremely

difficult. Are SSSIs, biodiversity and forests in a state that will enable them to recover from drought and flooding? Are there suitable management processes in place?

Some other "natural" elements are more difficult to assess. For example, as climate change increases the likelihood of hotter summers and heavier downpours, developing our networks of natural green space will become increasingly important for providing shade and absorbing heat and for providing natural drainage systems to absorb surface water. Increasing the number and the linkages between our green spaces will increase resilience, but the means to quantify this are not straight-forward. The frequency and duration of low flows in rivers may be a measure of climate impacts, and a low flowing river won't be very resilient to drought, but at what level does this become critical and for what element – wildlife, plant life, abstraction, dilution of pollutants? All will have differing levels at which the impacts become critical. Hence the level of resilience is different for each of these elements.

5.4.1 Possible existing natural/environmental indicators

The Regional Sustainability Framework contains objectives and indicators which are suited to providing the monitoring elements for the natural aspect. These include indicators:-

- 15a (Properties at risk from flooding)
- 15b (Number of planning permissions granted contrary to the advice of the Environment Agency on flood defence grounds);
- 15c (New development with sustainable drainage installed);
- 15d (Number of additional houses where flood risk has been reduced);
- 16a (Days when air pollution is moderate or high);
- 19a (Population of wild birds);
- 19b (Conditions of Sites of Special Scientific Interest (SSSIs));
- 19c (Extent and condition of key habitats for which BAPs have been established);
- 20b (Area of land covered by HLS and ELS environmental stewardship schemes);
- 24a (Rivers of good or fair chemical and biological quality);
- 24e (Per capita consumption (PCC) of water)
- 25a (Energy use per capita);
- 25b (Installed capacity for energy production from renewable sources).

Objective 18 is to:- "*Ensure that the South East is prepared for the impacts of climate change"*. As such, this is the objective under which a resilience indicator could sit.

The overall environmental objective of "A South East that lives with environmental limits" also includes the objective, number 22, "*To reduce the*

global social and environmental impact of consumption of resources by using sustainably and ethically produced, local or low impact products" with the associated indicator 22a (Regional Ecological Footprint). This could also contribute to the natural aspect of resilience, however as it is in itself made up of a number of elements it has not been used here.

Other indicators that have been collected could be used for the basis of a compound indicator; i.e. they could provide the individual elements for the natural aspect. Examples of these include:-

- Land covered by management schemes;
- Buildings of Grade I and II* at risk of decay;
- Capacity during "critical periods" to supply water without the need for restrictions.

5.4.2 Possible new natural/environmental indicator

It is also possible to consider a new indicator (provided that data exists and is easily collectable), e.g. *Net change in protected habitats,* (This is close to existing RSF indicator 19b (Conditions of Sites of Special Scientific Interest (SSSIs)), but sufficiently distinct to be useful.

This has the advantage of being a dynamic indicator as opposed to the current static indicators that only look at the existing sites, some of which may become untenable as a result of climate change. This indicator would assess the net change as habitats change. This could also be weighted to give consideration to the relative quality of the habitats. However, any such weighting should be done, if at all, within the development and monitoring of the indicator rather than when it is utilised as one of the resilience indicator set.

Benefits

- Looks at the net change in habitats, rather than considering those that already exist.
- Could include an assessment of the quality of the habitats.
- Reasonably extensive monitoring already in place.
- Includes the presumption that habitats will and should change over time as the climate changes. It is therefore more about managing change than preservation at all costs.

Drawbacks

- May change only very slowly over time.
- Message that habitats loss is inevitable needs management.
- Climate change only a contributory factor to changes.
- The regional bodies can influence only at the margin.

5.5 Assessment and scoring

There are many different scoring systems that could be used to assess the contribution to each aspect made by the individual indicators. However, nothing could be found in the literature to adequately cover this issue when considering the resilience of a region to climate change. As a result we have used our experience in other areas to propose a system of scoring which is both robust and repeatable. It is not however the only method that could be applied to this issue.

An early question to be considered is the number of individual indicators chosen to contribute to each of the aspects. We have chosen to use 5. This decision was based on fact that this number was sufficient to cover a range of elements in each aspect, while not being too many to make the process excessively onerous. Clearly there is not a "right or wrong" in this – it is a matter of judgement, and other conclusions would be valid.

At the outset, following the selection of the existing indicators that contribute to the understanding of regional resilience, a decision is needed as to what constitutes "reasonable" performance. As these indicators had initially been selected for their ability to measure and report on key issues for the region, and the targets have been agreed by regional experts and stakeholders, it is proposed that a performance that achieved the target should be given a relatively high score. It is proposed that a high mid-point should be given to this level of performance; e.g. 70 - 75% of the potential maximum score.

Subjective assessment is then used by the assessing group as to whether or not the recorded performance is significantly above or below target, or moving towards or away from the target and scored accordingly.

5.5.1 Methodology

One of the principle challenges involved in assessing resilience is the need to compare disparate elements from the economic, environmental and social aspects. However, this issue has been successfully addressed, at least on occasion, when dealing with sustainable development. There are two principle issues that need to be considered. The first is the need to make subjective judgements when comparing one aspect with respect to another. The second is the need to define some sort of scoring system.

The question of making a judgement between one aspect and another is always subjective and one individual's view would differ from another's. However, if this assessment is undertaken by a group the impact of individual preferences can be modified. One of the benefits of the approach suggested here is that the indicators that form the individual elements of each aspect are those that are already being measured to support other activities in the region. Accordingly they do not require, at least at present, additional monitoring. Additionally, when comparing one year with another it is possible to compare the contribution towards regional resilience made by each aspect in each period, thereby comparing "like with like". Finally, because a number of indicators are used for each aspect, a change in any one of them does not radically change the overall picture, removing a potential cause of distortion.

5.5.2 Weighting

It is proposed that weighting of individual indicators should not be applied. The reason for this is simple. It is by no means clear that any one indicator contributes *significantly* more to regional resilience than another. For example, is it possible to say that the availability of open space contributes more to resilience than an educated and mobile workforce? It is not considered that this is possible in a robust way.

While it may be the case that indicators could be developed that are more obviously resilience sensitive, for example the number of houses adapted to climate change, it is less clear that this should then be given a weighting to make it more important than another less obvious indicator. Particularly as in this case it would require a very significant percentage of all the dwellings in the region to be so adapted to have a significant impact. As a result, it is recommended that at this point in the development of resilience indicators no weighting should be used.

5.5.3 Scaling

The second criteria to be agreed, is the scale. A number of possible scales were considered. The first was a 0 -100, or percentage, scale. This was quickly rejected on the grounds that it implied that too precise a granularity could be sensibly achieved. This becomes clear if an indicator related to "Knowledge based GVA" is considered. It is possible to measure this with some precision and assess the change from one period to another, to a single percentage point or less. However, while it is clear that this is an issue that contributes to regional resilience, it is difficult to quantify that contribution to anything like the same degree of precision.

Following this, scales of 1 – 10 and 0 – 5 were considered. The fundamental rationale behind these is simply that they are scales with which people are used to working. We do not believe that there is a significant difference between them, but that on balance a scale of 0 – 5 better reflects the uncertainties inherent in any assessment of resilience.

5.5.4 Scoring

As a result, a score of 3.5/5 is given to an indicator that achieves the target performance. A performance exceeding this would then be scored greater than this as judged by the group undertaking the assessment. A performance failing to reach target, but moving towards it, i.e. making a positive contribution to increasing regional resilience, would be assessed at a small positive score between 0.5 and 3.0 depending on the gap between performance and target. An indicator moving away from the target, i.e. making the region less resilient, would be scored at 0. This disconnect is intentional to highlight elements that are making the region less resilient. An indicator that had not changed would be scored at the same level as in the previous period.

5.5.5 Composite score - Sum, product or average?

The final point to consider is to whether to use the sum, product or average of the constituent indicators to arrive at the combined "score" for each aspect.

It is easy to exclude the product, as any indicator scoring zero would result in a zero product. The sum has merits in that it expands the overall scale of the combined indicator. However, a poor performance by any individual indicator in any particular year can then result in excessive swings in the overall result. Using the average has the merit of dampening down these swings and prevents any one indicator having excessive influence. As a result it is proposed that the average score of the component indicators is used.

5.5.6 Benchmarking

When developing a resilience indicator, the real question that needs to be asked is whether or not we are more resilient (to climate change) than we were. If this is the case, then not only are we resilient to more events, we are likely to recover from extreme events more rapidly, because the resulting damage is less. Therefore in this case the importance of benchmarking is not about absolute measurement, or comparison with elsewhere, it is internal to the region and testing whether we are becoming more resilient than in a previous time period.

The ability to benchmark and to make comparisons between organisations, or areas, is frequently the raison d'etre behind indicators in the first place. However, when dealing with the impacts of climate change this is at best risky and at worst entirely invalid.

One of the key elements of climate change that is often not immediately recognised is that the same change can have different, or even opposite, effects in different locations. For example, an increase in rainfall in a gently sloping valley with good soils could be beneficial, promoting increased growth. The same increase in a steeply sided valley with very friable soils could result in rapid soil loss and degradation of the landscape. As a result, the "place" is in many respects as important as the change that is occurring.

When considering benchmarking within a region, the temptation is to ask "when will we be resilient?" The answer to this is "It depends on what climate you wish to be resilient to (and when will that occur)." The reality is that we can never be resilient to all eventualities. For example, you could design infrastructure to be resilient to a 0.1% probability event, but if you are then faced with a more extreme event with a 0.09% probability – you will be overwhelmed.

As a result the concept of absolute resilience has little or no meaning; it is always relative to some other state. There is indeed a risk associated with seeking absolute resilience as an event may occur that exceeds those for which you have planned. Similarly in making comparisons with another region, what is overlooked is the fact that the impacts of climate change are always a combination of the event itself and the environment in which it occurs. As a result spatial comparisons are often misleading.

6 Summary

The preceding sections illustrate that consideration of resilience indicators is not trivial. When applied to "measuring" resilience, the meaning of traditional "state" indicators can change over time and location when considering climate change impacts and an aspect's resilience to those impacts. As a result a different approach is considered to be more meaningful.

This approach combines a number of conventional "state" indicators with the impact approach used in environmental assessment to produce an assessment of resilience for each aspect – economic, social and natural. These are then combined on a radar graph to produce a representation of the area's resilience, which can be compared over time.

Following discussion with the Regional Assembly it was agreed that the indicators from the Regional Sustainability Framework would be used to give an example of what this approach could achieve. As previously discussed in section 5.5 we have chosen to select 5 indicators for each aspect. These are shown below.

However, it is important to note that indictors that could contribute to a compound regional resilience indicator are not restricted to those used to support the Regional Sustainability Framework. They could come from a very wide range of sources including, but not limited to the Regional Economic Strategy, the State of the Environment Report and observational databases such as the National Health Service health inequalities database. Similarly, new indicators could be developed over time that would better represent elements of resilience than those that are currently collected, and should be used in place of those.

6.1 Social indicators:-

These are the 5 existing RSF indicators that we have chosen to cover the social dimension.

- 1f (Percentage of new build and retrofit homes meeting Ecohomes Very Good standard or above or equivalent Code for Sustainable Homes);
- 2d (Life expectancy)
- 2g (The extent to which older people receive the support they need to live independently at home);
- 7b (Percentage of rural households at set distance from key services)
- 7c (Access to natural greenspace)

However, there are indicators that could be situated under different aspects. For example, the flooding indicators under the natural aspect could also be considered as being equally appropriate under the social aspect. There are also an additional 5 social indicators that could have been used, listed in 5.2.1, but in our judgement they were less appropriate that those above.

6.2 Economic indicators :-

These are the only existing RSF indicators that that we feel have a sufficiently strong connection with climate change resilience to cover the economic dimension.

- 10a (Real GVA per capita growth);
- 11a (Number of income support claimants in the 20% most deprived areas);
- 12a (The percentage of total south east business turnover attributable to new (new to market) and significantly improved products);

- 12c (The expenditure on R & D as a proportion of GVA);
- 13b (Working age population qualified to at least level 4 or higher).

6.3 Natural indicators :-

These are the 5 existing RSF indicators that that we have chosen to cover the natural aspect.

- 15a (Properties at risk from flooding)
- 15b (Number of planning permissions granted contrary to the advice of the Environment Agency on flood defence grounds);
- 15c (New development with sustainable drainage installed);
- 20b (Area of land covered by HLS and ELS environmental stewardship schemes);
- 24e (Per capita consumption of water);

These are 5 of the 11 RSF natural indicators listed in 5.4.1 as being related to resilience. Choosing between these is always a matter of opinion, but in our judgement those listed above were considered to me more pertinant than the others.

6.4 Indicator summary

These indicators have been used to produce Figure 6.1. Section 4.2 explains the rationale behind using a "radar plot" to display the data. However, as the data for this report is for a single year it does not show a trend.

The data suggests that the region appears to be most resilient from the social followed by the economic aspect. It is least resilient from an environmental aspect. However it is important to note that this is based on new RSF indicators for which there is no data trail showing progress over time for a number of the indicators. As a result this should be used to inform the basis of discussion about a resilience indicator for the region rather than be considered as a result.

The underlying data table is shown as Table 1

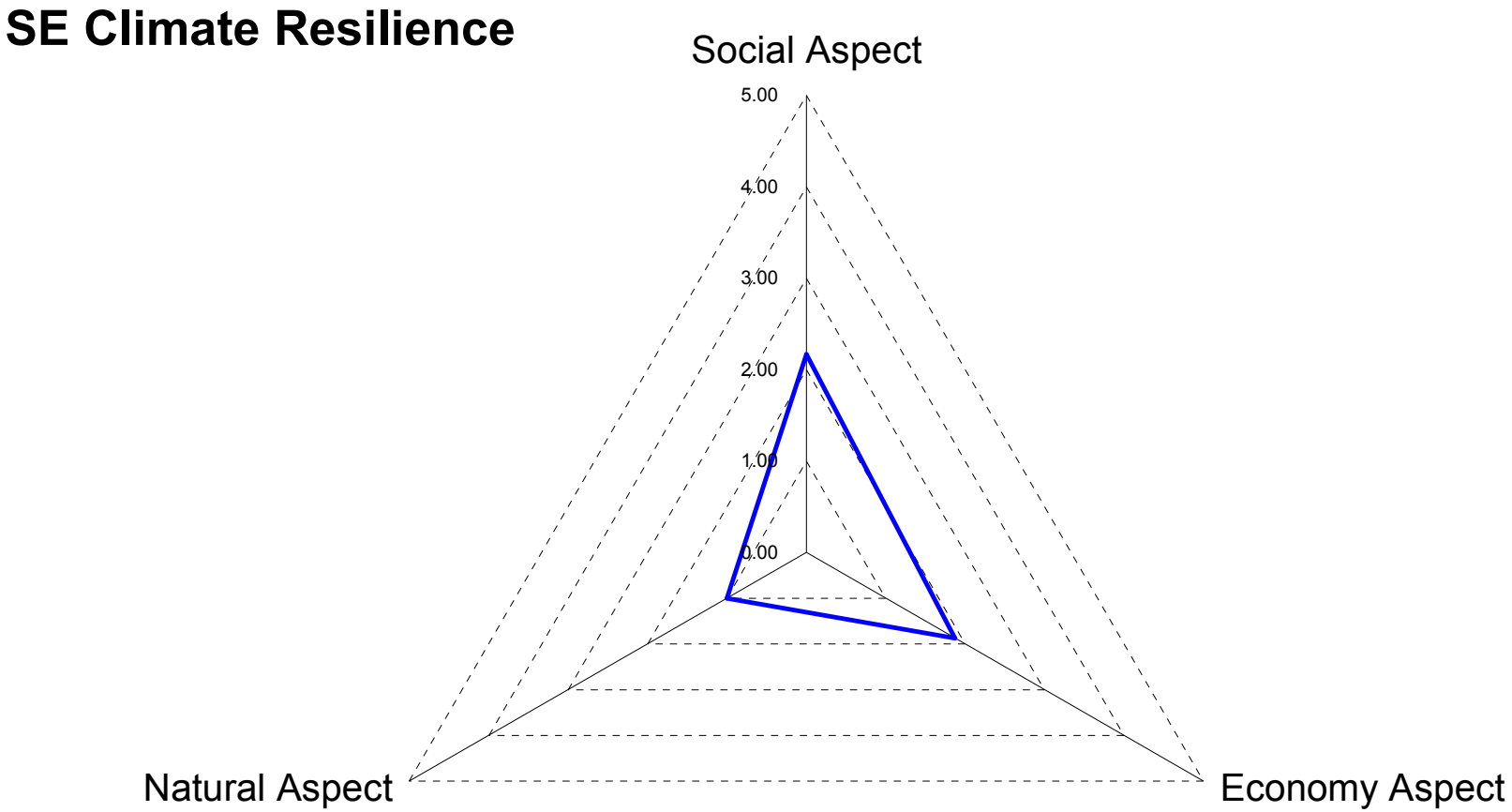


Figure 6.1 - SE Draft Resilience Indicator

SEERA Resilience Indicators						
	Score (Out of 5)					
Social Aspect	**2.17**			Latest Year	Pervious Year	Comment
RSF 1f	0.50		-			New Indicator, but V few built to this standard as a % of total new build
RSF 2d	3.50		+	F: 82; M: 78.1		+ F & M + 3 yrs; cf 1991-93
RSF 2g	-		No Data			New Indicator
RSF7b	2.50		~			Access to cashpoints, doctors +ve; Banks, building socities, post offices -ve; schools neutral
RSF 7c	-		No Data			New Indicator
Economy Aspect	**1.88**					
RSF 10a	2.50		+	1.90%	2.80%	GVA grown by avg. 3.4% p.a.
RSF 11a	1.00		- -	94,775		Worse - one indicator shown increase from 0.57% - 0.8% between 2006 & 2007
RSF12a	-		No Data			SE % turnover new productsw - 12%; and improved products 18%. Cf target of 20 and 25% respectively by 2016 - NEW INDICATOR
RSF 12c	0.00		-	2.9	3.1	Target to go from 3.2% to 4% by 2016
RSF 13b	4.00			30.5	29.5	Significant and steady increase
Natural Aspect	**1.00**					
RSF 15a	1.00		-	310,000	235,000	Data from RSF, BUT definition changed)
RSF 15b	1.00		~		24*	* 2004/05
RSF15c	-					New Indicator
RSF 19a	-		No Data			New indicator
RSF 23a	1.00		-			in 2005/6 weighted average consumption was 161 ltrs/day. 10 years to 05/06 shows increase of c. 6 %
Resilience Score						
Social Aspect	**2.17**					
Economy Aspect	**1.88**					
Natural Aspect	**1.00**					

Table 1- SE Draft Resilience Indicator; Underlying Data

7 Future developments

The final area to consider when addressing resilience indicators is the dynamic nature of the situation they are intended to measure. Climate change presents us with a wide variety of pressures, and the relative urgency of these pressures may change significantly, over time, from area to area, and as our response to climate change develops.

Therefore we believe that it is impossible to generate a single set of indicators to measure resilience for all time. The set developed in the discussion above is felt to be the most relevant and measurable set of indicators for the South East region at the present time. There is a long term need to review these indicators and ensure that they reflect the current realities of climate adaptation in the future – The situation in 2027, or 2050 will be significantly different from the situation in 2008. It is currently considered that flooding presents the largest immediate threat to the South East region from climate change, but other pressures will develop over time.

A good example of this is demand on water resources. As it is not currently anticipated that meeting the demand for water will become unmanageable in the period to 2026, water demand was not considered an essential element of the indicator set. The decisions made in this period have the potential to change this significantly. For instance, if a large number of water intensive industries, such as paper making or pharmaceuticals, are encouraged in the region then as the century progresses it may well become desirable to include pressure on water resources in the indicators as an essential element.

8 Conclusion

There is little in the literature to suggest that means to assess a region's resilience to climate change have been developed, or are being developed elsewhere. Informal discussions with climate change adaptation practitioners from around the UK, supports this view. As a result we believe that this may represent a novel approach to using pre-existing indicators as a means to measure the development of a region's resilience to climate change.

This exercise demonstrates a method for assessing the regions resilience and reporting how that resilience might change over time. The approach adopted appears to have merit and to warrant further discussion and dialogue with key regional stakeholders prior to any further dissemination.

In order to maximise the benefit of this approach, the development over time, of more targeted indicators is recommended and some examples of possible new indicators have been made. The current availability of the data to support the possible new indicators has not been researched, but this report contemplates what might constitute a good indicator might be for each aspect

The exercise suggests that the region's economy and social fabric are currently more resilient to climate change than its environment.

In addition to including this resilience indicator in the Regional Monitoring Report, it is felt that the maximum benefit can be gained from it if it is used to inform decisions about adaptation at a regional level. It could also be used to

contribute to the development of a regional Vulnerability Assessment as discussed in PPS1. However, detailed guidance on this has yet to be produced.

The draft climate change bill includes reference to an "assessment of risks" (from climate change) and the requirement for a report to Parliament on this assessment. At this point in time it is not clear what role regional bodies will play in the production of this report. However, whatever this role may be, an indicator of regional resilience will be a useful tool in explaining and illustrating the issues involved in responding to inevitable climate change.

While the indicator proposed cannot provide an absolute measure of resilience (see Section 5.5.6 on benchmarking for a discussion of "absolute resilience"), it does provide a good relative measure. If it is accepted that the region should become more resilient as one part of its response to the challenges of global climate change; then the indicator provides a means to guide that response so that all aspects of the region's wellbeing are safeguarded, and a measure of progress in building resilience within the region.

Annex 1 - Sample indicator sets

This annex covers examples from the United Kingdom as well as International examples.

The topic of climate change resilience indicators is relatively new and few examples relevant to South east England could be found. Defra has undertaken work to develop adaptation indicators, but these are not the same as resilience indicators. There has been a great deal of debate with the climate change field as to what would constitute a "state" indicator for climate change, as the existence of such implies and absolute measure of good or less good adaptation. It is not clear that such a thing exists. As such, adaptation indicators have tended to veer towards process indicators as in the new indicator NI188 for the Comprehensive Performance assessment.

The Defra indicators were reviewed for their suitability for use as a resilience indictor for South East England, but not felt to add to those reviewed locally. Two of the English regions have developed/use indicators in respect of climate change. These are listed below and have been assessed to inform the discussion in Sections 3 and 4.

Defra's approach for an adaptation indicator.
http://www.defra.gov.uk/environment/localgovindicators/pdf/Indicators/Adaptation.pdf

East of England

Water resources

Supply-demand balance (compare with projected demand)

No. of drought orders issued

Planning and infrastructure

Spatial distribution of dwellings

Changes to areas of biodiversity importance

Condition of strategic road network

Planning permissions granted contrary to Environment Agency advice on grounds of flood defence or water quality.

Climate change included as a priority in the Integrated Regional Strategy.

Number of coastal sites where managed realignment has taken place.

Number of properties in areas of flooding (more than 1/200)

No. of extra properties protect by flood defences

No. of properties registered on floodlines direct or per cent of properties at risk from flooding registered for some form of warning

Proportion of non-structural local authority actions in agreed Catchment Flood Management Plans (CFMP) and Shoreline Management Plans (SMP) that are being undertaken satisfactorily. (from Defra) http://www.defra.gov.uk/environment/localgovindicators/pdf/Indicators/FloodManagement.pdf

Business and community

Number of companies with an environmental management system

Action on climate change by community

Biodiversity

Number of species at risk

Condition of trees

Fish stocks

State of SSSIs (e.g. suffering from drought, recovering?)

Heritage

The number of ancient monument deemed at risk by English Heritage

Schools

Sustainable development being taught at schools

Health

Number of time ozone levels exceeded (will increase with hotter summers if not addressed)

Yorkshire and Humber

Includes a range of transport indicators. – See http://www.wyltp.com/NR/rdonlyres/6BE0D46E-8C26-4B84-9DB4-83A83B517A13/0/060626SEAappendix4.pdf -

Amount of development within identified floodplain.

Frequency and duration of low flows in rivers

Net change in natural habitats

Number of councils with climate risk integrated with business planning /risk assessment.

Climate change mitigation and adaptation actions included in CPA process.

International

Buckle et al. "New approaches to assessing vulnerability and resilience"[4] provides useful background into the concepts of vulnerability and resilience.

Element	Description
Shared community values, aspirations and goals	Including a shared and positive sense of the future, a commitment to the community as a whole and agreement of community goals as well as a shared culture
Established social infrastructure	Such as information channels, social networks and community organisations such as sporting and social clubs
Positive social and economic trends	Such as a stable or growing population, a healthy economic base
Sustainability of social and economic life	Which embraces a capacity for the community to weather disruption
Partnerships	Partnerships between agencies, between community groups and between commercial enterprises, or any combination of these, may bring innovation, sharing of experience, knowledge and resources and common goals. This applies particularly where the partners play a dominant role in the social and economic life of the town, such as towns dominated by a particular industry or economic activity.
Communities of interest	Where a group may exist over a wide area and be otherwise socially diverse but they share a common area of interest, skill or expertise. This includes communities bound together by faith and religious commitment, cultural groups as well as less formal groups such as business or commercial associations or sporting or recreational clubs.
Established networks	Clear and agreed and stable links between people and groups facilitate the exchange of information as well as the sharing of resources and the commitment of skills, time and effort to planning and preparedness.
Resources and skills	The resources and skills available locally may be directly relevant to emergency management planning,

[4] Buckle P, Marsh G, Smale S, 'New approaches to assessing vulnerability and resilience'. *Australian Journal of Emergency Management* 15(2) pp. 8-14 (Winter 2000).

http://www.ema.gov.au/agd/EMA/rwpattach.nsf/viewasattachmentpersonal/(C86520E41F5EA5C8AAB6E66B851038D8)~New_approaches_to_assessing_vulnerability_and_resilience.pdf/$file/New_approaches_to_assessing_vulnerability_and_resilience.pdf

	preparedness and for community support if an emergency does occur. These can be identified by the type of resource or skill, its amount, the cost to use it, its availability and by its location. Where useful resources or skills do not exist then they may be developed or promoted as part of preparedness activities.